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**TRANSMITTAL OF APPEAL BRIEF (Large Entity)**

Docket No.  
**ARC920000067US1**

In Re Application Of: **Emanuel I. Cooper, et al.**

(13521)

Application No.	Filing Date	Examiner	Customer No.	Group Art Unit	Confirmation No.
09/634,171	August 9, 2000	John P. Sheehan	23389	1742	5758

Invention:

**COFE ALLOY FILM**

**COMMISSIONER FOR PATENTS:**

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on  
**November 4, 2005**

The fee for filing this Appeal Brief is: **\$500.00**

- ☐ A check in the amount of the fee is enclosed.
- ☒ The Director has already been authorized to charge fees in this application to a Deposit Account.
- ☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **19-1013/SSMP**
- ☐ Payment by credit card. Form PTO-2038 is attached.

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*Signature*

Dated: **January 9, 2006**

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(Date)

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**Leslie S. Szivos, Ph.D.**

*Typed or Printed Name of Person Mailing Correspondence*



**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

**Applicant(s):** Emanuel I. Cooper, et al.

**Examiner:** John P. Sheehan

**Serial No.:** 09/634,171

**Art Unit:** 1742

**Filed:** August 9, 2000

**Docket:** ARC920000067US1 (13521)

**For:** COFE ALLOY FILM

**Dated:** January 9, 2006

**Confirmation No.:** 5758

Mail Stop Appeal Brief-Patents  
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P.O. Box 1450  
Alexandria, VA 22313-1450

**APPEAL BRIEF UNDER 37 C.F.R. §41.37**

Sir:

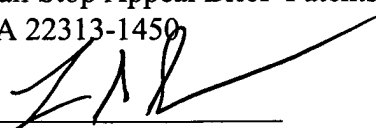
Pursuant to 35 U.S.C. §134 and 37 C.F.R. §41.37, entry of this Appeal Brief in the above-identified patent application is respectfully requested. This paper is submitted as a brief setting forth the authorities and arguments upon which Appellants rely in support of the appeal from the Final Rejection of Claim 1, 3-10 and 28-30 in the above-identified patent application on August 4, 2005.

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**CERTIFICATE OF MAILING UNDER 37 C.F.R. §1.8(a)**

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Dated: January 9, 2006

  
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Leslie S. Szivos, Ph.D.

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**1. STATEMENT OF REAL PARTY OF INTEREST**

The real party of interest in the above-identified patent application is Hitachi Global Storage Technologies.

**2. STATEMENT OF RELATED APPEALS AND INTERFERENCES**

There are no pending appeals or interferences related to this application to Appellants' knowledge.

**3. STATEMENT OF THE STATUS OF THE CLAIMS**

**A. Claim Status**

Claims 1, 3-10 and 28-30 have been finally rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the article to E.M. Kakuno, et al. entitled "Structure, Composition, and Morphology of Electrodeposited  $\text{Co}_x\text{Fe}_{1-x}$  Alloys", J. Electrochemical Soc., Vol. 144, No. 9, September 9, 1997, pp. 3222-3226 ("Kakuno, et al.") in view of U.S. Patent No. 4,695,351 to M.L. Mallary ("Mallary").

**B. Appealed Claims**

Claims 1, 3-10 and 28-30 are appealed, a clean copy of which is attached hereto in Appendix A.

**4. STATEMENT OF STATUS OF AMENDMENTS**

The claims were not amended in the Response to the Final Rejection filed August 4, 2005.

**5. SUMMARY OF CLAIMED SUBJECT MATTER**

The invention, with respect to Claim 1, comprises a cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, said film being anisotropic and consisting of a binary alloy  $(100\%-x)\text{Co}(x)\text{Fe}$ , where x is between about 60% and about 75% by weight (page 11, lines 7-13; and page 13, lines 1-19 of the specification).

The invention, with respect to Claim 3, comprises an alloy film in accordance with Claim 1 wherein said iron constituent is present in an amount of between about 62% and about 65% (page 13, lines 1-10 of the specification).

The invention, with respect to Claim 4, comprises an alloy film in accordance with Claim 1 wherein said saturation magnetization is in the range of between about 2.32 and about 2.53 Tesla (page 13, lines 12-19 of the specification).

The invention, with respect to Claim 5, comprises an alloy film in accordance with Claim 4 wherein said saturation magnetization is in the range of between about 2.38 and about 2.50 Tesla (page 13, lines 12-19 of the specification).

The invention, with respect to Claim 6, comprises an alloy film in accordance with Claim 1 wherein said film has an anisotropy, as manifested by an easy axis coercivity of no more than about 22 Oe, which drops to no more than about 12 Oe after being annealed; a hard axis coercivity of no more than about 17 Oe, which drops to no more than about 9 Oe after being annealed; and a magnetic anisotropy of no more than about 30 Oe, which is unchanged after being annealed (page 13, lines 21-28 of the specification).

The invention, with respect to Claim 7, comprises an alloy film in accordance with Claim 6 wherein said easy axis coercivity is no more than about 17 Oe, which drops to no more than about 8 Oe after being annealed; said hard axis coercivity is no more than about 7 Oe, which drops to about 3.5 Oe after being annealed; and a magnetic anisotropy of no more than about 24 Oe, which is substantially unchanged after being annealed (page 13, line 30 to page 14, line 5 of the specification).

The invention, with respect to Claim 8, comprises an alloy film in accordance with Claim 7 wherein said easy axis coercivity is no more than about 15 Oe, which drops to no more than about 6 Oe after being annealed; said hard axis coercivity is no more than about 5 Oe, which drops to no more than about 2.5 Oe after being annealed; and a magnetic anisotropy of no more than about 20.5 Oe, which is substantially unchanged after being annealed (page 14, lines 7-14 of the specification).

The invention, with respect to Claim 9, comprises an alloy film in accordance with Claim 1 wherein said film has a specific resistivity in the range of between about 17 and about 65  $\mu\Omega\text{-cm}$  (page 14, lines 16-21 of the specification).

The invention, with respect to Claim 10, comprises an alloy film in accordance with Claim 1 wherein said film has an internal mechanical stress resistance in the range of between about 250 and about 800 MPa (page 14, lines 23-29 of the specification).

The invention, with respect to Claim 28, comprises an alloy film in accordance with Claim 1 wherein said film has a thickness of not more than 2 microns (page 11, lines 3-5; and page 12, lines 27-29 of the specification).

The invention, with respect to Claim 29, comprises a magnetic recording head comprising a cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, said film being anisotropic and consisting of a binary alloy (100%-x) Co(x)Fe, where x is between about 60% and about 75% by weight (page 10, lines 23-25 of the specification).

The invention, with respect to Claim 30, comprises a cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, a thickness of not more than 2 microns and a substantially smooth, bright surface, said film being anisotropic and consisting of a binary alloy (100%-x) Co(x)Fe, where x is between about 60% and about 75% by weight (page 10, line 27 to page 11, line 5; and page 12, lines 27-31 of the specification).

## **6. GROUND OF REJECTION TO BE REVIEWED ON APPEAL**

The issue presented for review, on appeal, is whether Claims 1, 3-10 and 28-30 are unpatentable under 35 U.S.C. §103(a) over the article to E.M. Kakuno, et al. entitled "Structure, Composition, and Morphology of Electrodeposited  $\text{Co}_x\text{Fe}_{1-x}$  Alloys", J. Electrochemical Soc., Vol. 144, No. 9, September 9, 1997, pp. 3222-3226 ("Kakuno, et al.") in view of U.S. Patent No. 4,695,351 to M.L. Mallary ("Mallary").

**7. ARGUMENTS**

**A. The rejection of Claims 1, 3-10 and 28-30, on appeal, under 35 U.S.C. §103, as being unpatentable over Kakumo et al. in view of Mallary, is improper.**

**1. CLAIMS 1, 29, and 30**

In the Final Office Action, dated August 4, 2005, the Examiner rejected all the pending claims, namely, Claims 1, 3-10 and 28-30, under 35 U.S.C. §103(a) as unpatentable over the article to E.M. Kakuno, et al. entitled "Structure, Composition, and Morphology of Electrodeposited  $\text{Co}_x\text{Fe}_{1-x}$  Alloys", J. Electrochemical Soc., Vol. 144, No. 9, September 9, 1997, pp. 3222-3226 ("Kakuno, et al.") in view of U.S. Patent No. 4,695,351 to M.L. Mallary ("Mallary").

This obviousness rejection relies on the combined disclosures of Kakuno, et al. in view of Mallary for allegedly disclosing the claimed cobalt-iron binary alloy electroplated films recited in Claims 1, 3-10, 28, and 30, on appeal, as well as for allegedly disclosing the magnetic recording head recited in Claim 29, on appeal. Appellants respectfully disagree with the Examiner's position that the foregoing disclosures render Claims 1, 3-10 and 28-30, on appeal, obvious.

With respect to the present invention, the Examiner alleges that Kakuno, et al. disclose CoFe alloys having compositions that are encompassed by the alloy composition recited in the instant claims and Kakuno's alloys are made, in accordance with the Examiner's position, by an electroplating process substantially identical to appellants' disclosed method of making the claimed alloy films. The Examiner further alleges that Mallary discloses a method to induce magnetic anisotropy in electrodeposited magnetic films by electrodepositing the film in a magnetic field. Thus, the Examiner concludes that one skilled in the art, at the time of the invention, would have been motivated to apply a magnetic field to Kakuno's electroplating process to induce the required anisotropy in the CoFe alloy film. It is also the Examiner's position that applying the magnetic field

disclosed in Mallery to the composition and electroplating process disclosed in Kakuno, et al. would produce CoFe alloy films possessing all the same properties as recited in the instant claims.

Appellants respectfully submit that the disclosures of Kakuno, et al. and Mallery do not render Claim 1 obvious because Kakuno, et al. and Mallery, solely or in combination, fail to teach or suggest the claimed invention, i.e., *a cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, said film being anisotropic and consisting of a binary alloy (100%-x)Co(x)Fe, where x is between about 60% and about 75% by weight.*

Kakuno, et al. investigated the structure, composition and morphology of  $\text{Co}_x\text{Fe}_{1-x}$  alloys (where x is from 0 to 1) prepared on a copper substrate under potentiostatic electrodeposition conditions to produce composition modulated alloys. Mallery discloses a procedure for depositing a magnetic material onto a substrate, while subjecting the deposited magnetic material to a magnetic bias field in order to induce an anisotropic magnetic moment.

However, appellants respectfully submit that Kakuno's alloys are produced by a process substantially different from the process for preparing the claimed CoFe alloy films, and consequently Kakuno's alloys do not possess the characteristics of the claimed alloy films. It is imported to note that the subject matter relating to the process for preparing appellants' alloys has issued as U.S. Patent No. 6,855,240 B2 ("US 6,855,240") and Kakuno is listed in the Other Publications section on the cover of US 6,855,240. It is well-known in the art that different electroplating conditions cause different morphology and crystallinity of the resulting films and therefore even the properties of electroplated films with the same composition can vary significantly depending on the electroplating conditions, such as bath chemistry, mixing method, current density, pH and temperature.

Specifically, the plating bath of the process of the present invention uses specific additives, such as mono or polycarboxylic acid(s), boric acid, aromatic sulfinic acid or a salt thereof, optionally a halide salt, and optionally a surfactant (page 15, lines 9-20 of the specification); while the plating bath of Kakuno, et al. does not use any additives (Kakuno, et al., page 3222, the last paragraph of the right column). Furthermore, the plating bath of the present process uses a buffer and the bath has a pH of about 2.5 to about 3.5 (page 15, lines 9-20 of the specification). Kakuno, et al. do not adjust the pH of the plating bath (Kakuno, et al., page 3222, the last paragraph of the right column). Notably, the inventive CoFe alloy film prepared by the above-mentioned electroplating process is substantially free of oxygen and iron oxide (page 10, lines 27-31 and Page 12, lines 27-29 of the specification). That is, the present invention employs conditions in the electroplating process to prevent oxygen from incorporation into the alloy film during deposition. If no additive is employed, and no deaeration is performed during plating, as the process conducted in Kakuno, et al., oxygen continues to dissolve in the plating solution and be incorporated into the film. One skilled in the art is aware that higher oxygen content in CoFe alloy drastically reduces the magnetic moment of the CoFe alloy since neither cobalt oxides, iron oxides nor any combination thereof have magnetic moments remotely close to those of the unoxidized alloys.

Therefore, appellants respectfully submit that, even if, *arguendo*, the magnetic field disclosed in Mallary is applied to the composition and electroplating process disclosed in Kakuno, et al., the resulting alloy films would not possess the characteristics of the claimed alloy films, particularly, a saturation magnetization of 2.30 Tesla or greater, as claimed in the present invention.

Appellants have filed a 37 C.F.R. §1.132 Declaration of Hong Xu dated June 10, 2004 (“the §1.132 Declaration”) demonstrating that applying a magnetic bias to the alloy films prepared by the Kakuno, et al. process produces a magnetic moment that is less than appellants’ claimed range. A



copy of the §1.132 Declaration is attached hereto in Appendix B<sup>1</sup>. Specifically, as indicated by paragraph (9) of the Declaration (page 10), when the same magnetic field was applied to both the electroplating process of Kakuno, et al. and the electroplating process of the present invention, the magnetic moment for Kakuno's CoFe film comprising 64 wt % Fe is 2.2 Tesla, while the magnetic moment for the inventive CoFe film comprising 64 wt % Fe is 2.4 Tesla.

Appellants submit that the alloy film of Claim 1 is patentably distinguishable from the Kakuno's alloy because a magnetic moment of 2.3 Tesla is substantially different from a magnetic moment of 2.2 Tesla in the context of high-density magnetic recording. CoFe alloys have a wide application in magnetic recording industry, where every improvement in saturation magnetization is considered important. More magnetization can greatly improve the performance of magnetic recording devices because even a moderate magnetization improvement allows a higher field in the write pole of the recording head to be generated and therefore a higher coercivity recording media to be used. Consequently this media allows a higher density of bits to be recorded. It is well-recognized in the field that materials with a moderate difference in magnetic moment, such as 0.1 Tesla, can result in substantial differences in performance in high-density magnetic recording devices. Therefore, the alloy film of the present invention is distinctive and superior over Kakuno's alloy as high-density magnetic recording material.

Furthermore, the impurity level in Kakuno's alloy is significantly higher than that in the claimed alloy film. As indicated by paragraph (11) of the §1.132 Declaration (page 11), the oxygen and nitrogen content in Kakuno's alloy are 5.7 atomic% and 0.19 atomic% respectively, while the inventive alloy has well below 1 atomic% of oxygen content and is free of the nitrogen content.

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<sup>1</sup> Appellants observe that the Examiner has indicated that the §1.132 Declaration has been accepted for consideration in the Office Action dated August 4, 2005 (the paragraph bridging pages 4 and 5). Moreover, as indicated in the Office Action dated September 3, 2004 (pages 5-8) and in the Office Action dated February 17, 2005 (page 5, the last paragraph), the §1.132 Declaration has been considered by the Examiner.

Since the oxygen and nitrogen content is impurity, i.e., unwanted material that deteriorates the desired product, one skilled in the art would consider the combined 5.89% in Kakuno's alloy as significant. In light of the intended use of the inventive alloy films, i.e., use for magnetic recording devices as magnetic films, one skilled in the art would consider a near six-fold or more difference in impurity levels as significant because impurities such as oxygen or nitrogen can substantially reduce the magnetic moment of the alloy (the last paragraph on page 12 of the §1.132 Declaration). Although the impurity level is not explicitly claimed in the present application, appellants believe that the substantial absence of oxygen content is inherently necessary for a CoFe alloy to possess a saturation magnetization as high as 2.30 Tesla or greater.

In addition, as a material to be used in magnetic recording head, the inventive alloy is considerably different from Kakuno's alloy because the alloy film prepared according to Kakuno's process is not suitable for the above-mentioned use. It is common knowledge in the art that annealing is a necessary step in the process of fabricating thin film magnetic recording heads. However, Kakuno's film broke completely into small pieces after low temperature annealing (the last paragraph on page 9 of the §1.132 Declaration). In contrast, the inventive film containing equal amount of Fe are still intact after the same annealing treatment (the last paragraph on page 9 of the §1.132 Declaration).

The Examiner alleges that the §1.132 Declaration is not commensurate in scope to the claims. As indicated in the §1.132 Declaration, two embodiments of the present invention, i.e., CoFe alloy films containing 64% Fe and 76% Fe, are presented in the Declaration. Particularly, the inventive CoFe alloy film having a saturation magnetization of 2.4 Tesla contains 64 wt % Fe, which is squarely in the claimed range of about 60% to about 75% Fe by weight. Therefore, applicants submit that the Declaration is commensurate in scope to the claims.

“Ascertain the differences between the prior art and the claims at issue requires interpreting the claim language, and considering both the invention and the prior art references as a whole.” (emphasis added by appellants) See MPEP 2141.02. “In determining whether the invention as a whole would have been obvious under 35 U.S.C. §103, we must first delineate the invention as a whole. In delineating the invention as a whole, we look not only to the subject matter which is literally recited in the claim in question... but also to those properties of the subject matter which are inherent in the subject matter and are disclosed in the specification... Just as we look to a chemical and its properties when we examine the obviousness of a composition of matter claim, it is this invention as a whole, and not some part of it, which must be obvious under 35 U.S.C. §103.” *In re Antonie*, 559 F.2d 618, 620, 195 USPQ 6,8 (CCPA 1977) (emphasis added by appellants) (citations omitted).

In view of the present invention as a whole, it is respectfully submitted that the disclosures of Kakuno, et al. and Mallery, solely or in combination, fail to teach or suggest not only the claimed magnetic moment of 2.30 Tesla or greater, but also the inherent characteristic properties (e.g., the impurity level) of the claimed alloy films which are inherent in the claimed subject matter and are disclosed in the specification.

Furthermore, appellants respectfully submit that the rejection under 35 U.S.C. §103 also fails because there is no motivation in the applied references which suggests modifying the electroplating process disclosed in Kakuno, et al. to use specific additives in and adjust pH of the plating bath so that a CoFe alloy film having a saturation magnetization of 2.30 Tesla or greater can be obtained. Thus, there is no motivation provided in the applied references, or otherwise of record, to make the modification mentioned above.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the reference itself or in the knowledge generally available to one of ordinary skill in the art, to modify the reference. Second, there must be a reasonable expectation of success. Finally, the cited reference must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the reference, not based on applicants' disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

In the absence of motivation to modify the electroplating process disclosed in Kakuno, et al., the prior art references do not render Claim 1, on appeal, obvious.

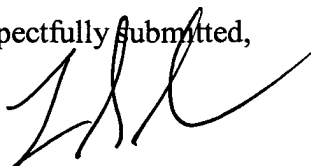
Independent Claims 29 and 30 recite similar features as Claim 1, and therefore are patentably distinct over Kakuno, et al. and Mallery for at least the reasons discussed in connection with claim 1.

In light of the various reasons articulated herein, appellants respectfully submit that the rejection of Claims 1, 29, and 30 for obviousness under 35 U.S.C. §103(a) is improper and must be withdrawn.

**2. CLAIMS 3-10 and 28**

Claims 3-10 and 28, which depend directly or indirectly from the independent claims 1, 29, and 30 incorporate all of the limitations of the corresponding independent claim and are therefore patentably distinct over Kakumo et al. and Mallary for at least those reasons provided for claims 1, 29, and 30.

Respectfully submitted,



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## APPENDIX A

### CLAIMS ON APPEAL: CLAIMS 1, 3-10 and 28-30

Application Serial No. 09/634,171

1. (Rejected) A cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, said film being anisotropic and consisting of a binary alloy  $(100\%-x)\text{Co}(x)\text{Fe}$ , where x is between about 60% and about 75% by weight.
3. (Rejected) An alloy film in accordance with Claim 1 wherein said iron constituent is present in an amount of between about 62% and about 65%.
4. (Rejected) An alloy film in accordance with Claim 1 wherein said saturation magnetization is in the range of between about 2.32 and about 2.53 Tesla.
5. (Rejected) An alloy film in accordance with Claim 4 wherein said saturation magnetization is in the range of between about 2.38 and about 2.50 Tesla.
6. (Rejected) An alloy film in accordance with Claim 1 wherein said film has an anisotropy, as manifested by an easy axis coercivity of no more than about 22 Oe, which drops to no more than about 12 Oe after being annealed; a hard axis coercivity of no more than about 17 Oe, which drops to no more than about 9 Oe after being annealed; and a magnetic anisotropy of no more than about 30 Oe, which is unchanged after being annealed.

7. (Rejected) An alloy film in accordance with Claim 6 wherein said easy axis coercivity is no more than about 17 Oe, which drops to no more than about 8 Oe after being annealed; said hard axis coercivity is no more than about 7 Oe, which drops to about 3.5 Oe after being annealed; and a magnetic anisotropy of no more than about 24 Oe, which is substantially unchanged after being annealed.

8. (Rejected) An alloy film in accordance with Claim 7 wherein said easy axis coercivity is no more than about 15 Oe, which drops to no more than about 6 Oe after being annealed; said hard axis coercivity is no more than about 5 Oe, which drops to no more than about 2.5 Oe after being annealed; and a magnetic anisotropy of no more than about 20.5 Oe, which is substantially unchanged after being annealed.

9. (Rejected) An alloy film in accordance with Claim 1 wherein said film has a specific resistivity in the range of between about 17 and about 65  $\mu\Omega$ -cm.

10. (Rejected) An alloy film in accordance with Claim 1 wherein said film has an internal mechanical stress resistance in the range of between about 250 and about 800 MPa.

28. (Rejected) An alloy film in accordance with Claim 1 wherein said film has a thickness of not more than 2 microns.

29. (Rejected)        A magnetic recording head comprising a cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, said film being anisotropic and consisting of a binary alloy (100%-x) Co(x)Fe, where x is between about 60% and about 75% by weight.

30. (Rejected)        A cobalt-iron binary alloy electroplated film having a saturation magnetization of 2.30 Tesla or greater, a thickness of not more than 2 microns and a substantially smooth, bright surface, said film being anisotropic and consisting of a binary alloy (100%-x) Co(x)Fe, where x is between about 60% and about 75% by weight.



APPENDIX B

EVIDENCE SUBMITTED

Application Serial No. 09/634,171

A copy of the original 37 C.F.R. §1.132 Declaration of Hong Xu dated June 10, 2004 is herein enclosed as evidence entered by the Examiner and relied upon by the Appellants in this appeal.

Specifically, the Examiner has stated that the §1.132 Declaration has been accepted for consideration in the Office Action dated August 4, 2005 (the paragraph bridging pages 4 and 5). Moreover, as indicated in the Office Action dated September 3, 2004 (pages 5-8) and in the Office Action dated February 17, 2005 (page 5, the last paragraph), the §1.132 Declaration has been considered by the Examiner.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

<b>Applicant(s):</b>	Emanuel I. Cooper, et al.	<b>Examiner:</b>	John P. Sheehan
<b>Serial No:</b>	09/634,171	<b>Art Unit:</b>	1742
<b>Filed:</b>	August 9, 2000	<b>Docket:</b>	ARC920000067US1 (13521)
<b>For:</b>	COFE ALLOY FILM	<b>Dated:</b>	June 10, 2004

Commissioner for Patents  
P.O. Box 13450  
Alexandria, VA 22313-1450

**DECLARATION OF HONG XU UNDER 37 C.F.R. § 1.132**

Sir:

I, Hong Xu, hereby declare and say that:

(1) I am one of the applicants named in U.S. Application Serial No.

09/634,171, filed with the United States Patent and Trademark Office on August 9, 2000;

(2) I am familiar with the subject matter disclosed in U.S. Application Serial No. 09/634,171, filed August 9, 2000; and have reviewed the applied reference, namely the article to E.M. Kakuno, et al., entitled "Structure, Composition, and Morphology of Electrodeposited  $\text{Co}_x\text{Fe}_{1-x}$  Alloys", J. Electrochemical Soc., Vol. 144, No. 9, September 9, 1997 pp. 3222-3226 that was cited in the Office Action dated September 15, 2003;

(3) Additional experiments and data have been carried out to establish that the claimed composition is not obvious relative to the disclosure of Kakuno, et al. cited by the Examiner in the Office Action dated September 15, 2003. Specifically, experiments were performed to show differences between the inventive CoFe film and a film that was reproduced in accordance with the disclosure of Kakuno, et al. We also

measured the film composition, magnetic moment, resistivity, B-H loops, crystallinity and impurity concentration of the film prepared in accordance with the Kakuno, et al., disclosure and compared them to the CoFe film of the present invention. We also measured oxygen and nitrogen concentration in the plated films;

(4) The experiments performed and reported in this Declaration were conducted by me, or they were carried out under my direct supervision or control;

(5) Specifically, experiments have been performed to show that the cobalt-iron binary alloy electroplated film of the present invention has different properties as compared with the films that are obtained using the procedure disclosed in the Kakuno, et al. disclosure. Specifically, in the present invention a CoFe alloy composition prepared in accordance with the present invention was compared to the same alloy composition that was prepared in accordance with the disclosure of Kakuno, et al.

The properties of the electroplated CoFe films plated using the process of the present invention, as demonstrated herein, are significantly different from the CoFe films obtained using the process disclosed in Kakuno, et al. Since the present application and Kakuno, et al. use different plating processes, experiments comparing the two different techniques were conducted and the data provided herein shows that the alloy properties of electroplated CoFe films are not only related to alloy composition, but are also determined by other processing factors including the electroplating conditions, such as bath chemistry, with or without additives, mixing, current density, pH, temperature and magnetic field.

The data provided herein also shows that CoFe films produced using the Kakuno, et al. procedure have a high impurity concentration of oxygen (5.7 atomic %)

and nitrogen (0.19 atomic %) as compared to the claimed films of the present application which are recited to be substantially free of oxygen. This provides further support that the plating conditions affect alloy properties.

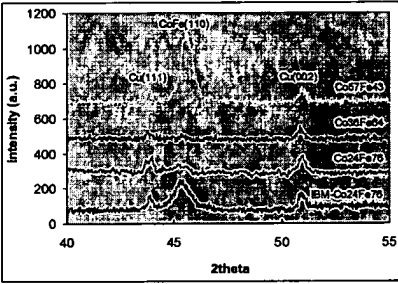
Magnetic properties, especially magnetic moment, are extremely sensitive to impurity concentrations in the films. All the applicants of the present application have experience with an additive free bath. It is one of the spirits of the present application to invent an innovative way to prevent CoFe from oxidation during plating, and to use a sulfate only bath to prevent the other impurity incorporation such as nitrogen, thus high magnetic moment of at least 2.3 Tesla can be achieved. It is noted that the present application doesn't preclude the presence of some oxygen and iron oxide in the plated CoFe film. However, in order to achieve the magnetic moment of at least 2.3 Tesla, the plated CoFe films have to be substantially free of oxygen and other impurities such as nitrogen.

(6) The electroplated film of the present invention was prepared using the method described in the application. Specifically, the CoFe alloy film of the present invention was provided by a process in which the film was electroplated from an aqueous chemical plating bath. The plating bath for an electroplated CoFe alloy film having 64 wt % Fe produced from the method of the present invention comprises acetic acid present in a concentration of 12 g/l; boric acid present in a concentration of 25 g/l;  $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$  present in a concentration of 19.07 g/l;  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  present in a concentration of 47.76 g/l; sodium benzene sulfinate present in a concentration of about 0.09 g/l; FC-95 surfactant present in a concentration of 0.01 g/l; and NaCl present in a concentration of 0.5 g/l. The plating bath for an electroplated CoFe alloy film having 76 wt % Fe

produced from the method of the present invention comprises acetic acid present in a concentration of 3 g/l; boric acid present in a concentration of 25 g/l;  $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$  present in a concentration of 19.07 g/l;  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  present in a concentration of 61.69 g/l; sodium benzene sulfinate present in a concentration of about 0.09 g/l; and FC-95 surfactant present in a concentration of 0.01 g/l; and NaCl present in a concentration of 0.5 g/l. The pH of the plating bath for the 64 wt % and 76 wt % CoFe layer is 3.0.

The electroplating operation was conducted in a paddle cell plating system at an average cathodic current density of between  $10 \text{ mA/cm}^2$  to about  $20 \text{ mA/cm}^2$ . The paddle cell used for plating the inventive film is described in U.S. Patent Nos. 4,102,756 and 3,652,442. In the set up, a Co anode and the wafer are parallel to each other in the horizontal direction with a separation distance of 3 mm. The paddle moves between anode and the wafer to provide vigorous and uniform mixing. The paddle cell improves the mass transfer of chemicals in the diffusion layer so that oxidation preventive chemical sodium benzene sulfinate can be transferred to the wafer surface efficiently to prevent the oxidation of plated Fe and Co during the plating process. In the meantime, continuous mixing in diffusion layer can stabilize the surface pH so that oxidation of plated Fe and Co can be minimized. The plating temperature was maintained at  $21.3^\circ\text{C}$  accompanied by a paddle speed of 1Hz. The plating apparatus included a cobalt anode. The wafer being plated comprises a conductive thin film of Cu.

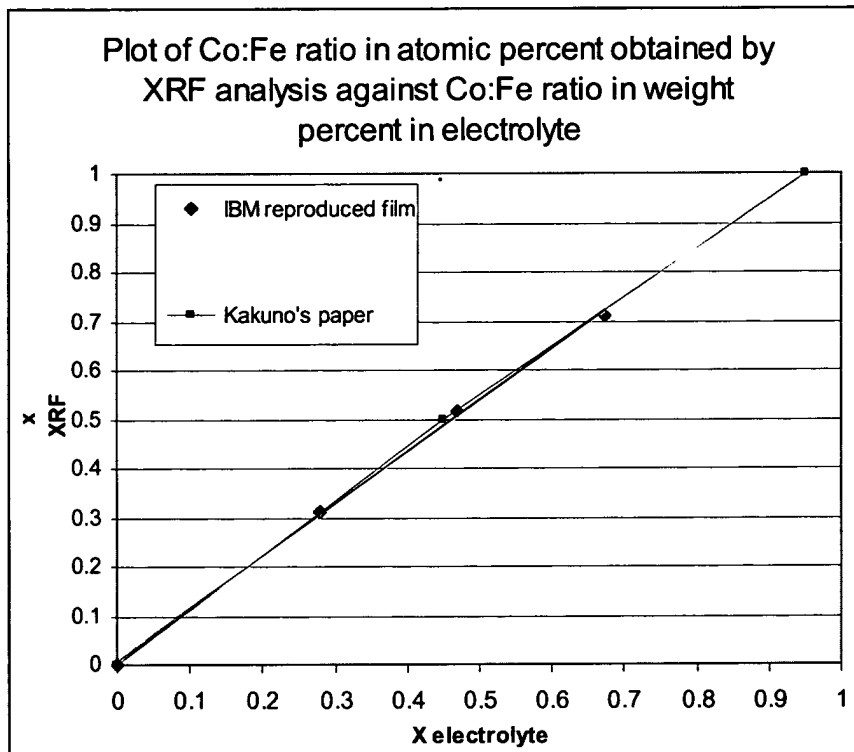
(7) The purpose of the following experiments aim to reproduce the CoFe films produced using the process disclosed in Kakuno, et al. using the conditions disclosed therein. The following table provides a description of the experimental set up that was used to form CoFe films provided in the Kakuno, et al. disclosure.

	<b>Kakuno's paper</b>	<b>Reproduced conditions used</b>	<b>Explain the differences</b>
Plating system	Stationary parallel plate;  Pt counter electrode;  Ag/AgCl reference electrode	Stationary parallel plate; 250 ml solution in beaker  Pt counter electrode;  Hg/HgSO <sub>4</sub> reference electrode	In Kakuno, et al., there is no information for the volume of the solution. A 250 ml solution was chosen for convenience.  A different reference electrode was used. All potentials are versus Hg/Hg <sub>2</sub> SO <sub>4</sub> reference, which is 0.4 V more positive than Ag/AgCl as reported in the paper. So the -1.6 V corresponds to Kakuno, et al. -1.2 V.
Power supply	EG&G PAR potentiostat/galvanostat (Model 273A)	EG &G PAR potentiostat/galvanostat (Model 273A)	
Substrate	(100) textured polycrystalline Cu plates mechanically polished with 1um diamond and then chemically polished.  Area of plates: 0.80 cm <sup>2</sup>  (see Figure 4 in Kakuno's paper for the structure of the substrate)	(100) textured polycrystalline Cu disks mechanically polished with 1um diamond  Area of plates: 0.98 cm <sup>2</sup>  The following graph is the x-ray diffraction data for the Cu substrate and reproduced CoFe films  	When one compares the X-ray diffraction data between Kakuno, et al. and XRD data of the present invention, one will find that the Cu disks have the same structure as Kakuno's plates, indicated by the same 2 theta location for the Cu (111) and Cu (002). The intensity of the peak is proportional to metal thickness.  The striking difference, as shown by the magnitude of the Co(110) peak, is in the much lower degree of apparent crystallinity in the high-Fe Kakuno compositions (Fe64 and Fe76) as compared to the Fe76 film of the present invention. This means that the grains in the Kakuno films are much smaller and that the relative volume of intergranular space (proportional to intergranular area) is much larger, and/or that the Kakuno films are much less textured, again probably due to intergranular phases interfering with textured crystal growth.
Bath chemistry	Reagent grade Cobalt Sulfate and Iron Ammoniac Sulfate immediately prior to each experiment;	Reagent grade Cobalt Sulfate and Iron Ammoniac Sulfate immediately prior to each experiment;	We can't dissolve required Cobalt Sulfate and Iron Ammoniac-Sulfate for 1M concentration at room temperature of 21 °C in our lab even overnight.

	X molar of metallic cobalt and 1-x molar of metallic iron.	X molar of metallic cobalt and 0.7-x molar of metallic iron.	In order to have a freshly prepared bath, 0.7M solution was used for plating. 0.7M concentration is already a highly concentrated solution. Study found that plated film composition is related to the ratio of $\text{Fe}^{2+}/\text{Co}^{2+}$ in the solution, not the absolute solution concentration (See results and discussion section).
Temperature	Room temperature; exact value not reported	Room temperature of 21 °C	none
Magnetic field	not mentioned	Not applied	none
PH	As prepared, not adjusted; not reported	As prepared, not adjusted; measured pH=3.55	none
Potential (V)	-1.0, -1.2, -1.4	-1.2	Since a different reference electrode was used, the potential for the condition shown is after conversion.
Surface quality	Shiny surface	Dark shiny surface	Kakuno, et al. didn't mention whether the film is dark shiny or bright shiny.

(8) Three CoFe samples (with Fe wt% 31.5, 51.7, 71.1, <1micron) were plated in the stationary system using the reproduced conditions specified in section (7) of this paper to provide samples representative of the CoFe films produced by Kakuno, et al. Our study shows that the composition of plated CoFe film is related to the iron/cobalt ratio in the solution, not the absolute concentration of Fe or Co in the solution. The three CoFe samples having the iron/cobalt ratio in the plating bath solution being tailored to provide CoFe samples having a Fe concentration equal to 31.5, 51.7, and 71.1 wt %. The CoFe samples produced by the reproduction conditions, specified in section (7) of this section, are consistent with the CoFe films depicted in FIG. 3 of the Kakuno, et al. disclosure. Referring to the following graph, the data points for the Co:Fe ratio in atomic weight percent obtained by XRF against the Co:Fe ratio in weight percent in the electrolyte measured from the CoFe samples produced by the reproduced conditions recited in section (7) are consistent with the data depicted in FIG. 3 of the Kakuno, et al.

disclosure. The following comparison of the data produced by the reproduction conditions recited in section (7) of this paper to the data depicted in FIG. 3 of the Kakuno, et al. disclosure illustrates the accuracy in which the Kakuno, et al. process has been reproduced in the present declaration.



The figure shown above is provided to explain our rationale for using the bath chemistry mentioned in the above table. We attempted to use the same concentration of 1M cobalt sulfate and iron ammoniac-sulfate as described in the Kakuno, et al. paper. However, we couldn't dissolve 1M cobalt sulfate and iron ammoniac-sulfate as used in the Kakuno, et al. article at room temperature in our lab even overnight. In order to have a freshly prepared bath, a 0.7M solution was used for plating. A 0.7M solution is a highly concentrated solution. The above figure shows that plated film composition is related to the ratio of  $\text{Fe}^{2+}/\text{Co}^{2+}$  in the solution, not the



absolute concentration. This figure agrees with Kakuno, et al. Hence, the figure shows that although we didn't use the same absolute salt concentration for the experiments as described in the Kakuno, et al. paper, absolute salt concentration won't effect the film concentration.

(9) The Kakuno, et al. CoFe films were plated in a stationary system without magnetic field using the reproduced conditions specified in section (7) of this paper. The inventive CoFe films were plated in a paddle cell with a paddle speed of 1Hz consistent with the process conditions recited in section (6) of this paper. The CoFe films plated in the stationary systems as practiced by Kakuno, et al. show isotropic properties instead of the anisotropic properties of the inventive CoFe films. Because of this isotropic behavior, magnetic moment data can't be obtained. Three CoFe films where deposited with the process disclosed in Kakuno, et al. using the reproduction conditions specified in section (7) of this paper, wherein the concentration of the metallic cobalt and metallic iron of the bath chemistry was modified to provide a CoFe film comprising 43 wt % Fe; a CoFe film comprising 64 wt% Fe; and a CoFe film comprising 76 wt % Fe. A fourth CoFe film comprising 76 wt % Fe was produced using the inventive process, as specified in section (6) of this paper.

Hysteresis curves (BH loops) were provided for each of the above-described CoFe films. Loop 1 represents the CoFe film produced by the Kankuno, et al. comprising 43 wt % Fe. Loop 2 represents the CoFe film produced by the Kankuno, et al. process comprising 64 wt % Fe. Loop 3 represents the CoFe film produced by the Kankuno, et al. process comprising 76 wt % Fe. Loop 4 represents the CoFe film produced by the inventive process, wherein the CoFe film comprised 76 wt % Fe. Loops

1-3 depict CoFe films having isotropic properties, wherein a magnetic moment is not obtained. Loop 4 depicts a CoFe film having anisotropic properties, in which a magnetic moment is obtained.

In order to obtain magnetic moment values for the CoFe films produced from the Kakuno, et al. plating composition, as recited in section (7) of this paper, two 5" wafers were plated with CoFe films using a plating bath chemistry that provided a CoFe alloy film comprising Fe at 64 wt % in a paddle cell plating system, similar to the paddle cell plating system utilized by the present invention. This system has 800 Oe magnetic field applied perpendicular to the paddle moving direction. The Kakuno, et al. plating chemistry, room temperature, pH not adjusted (measured pH=3.55) and current density of 20 mA/cm<sup>2</sup> were used. CoFe films (Fe at 64 wt %) using the Kakuno, et al. plating chemistry showed anisotropic behavior, which enabled us to measure the magnetic properties.

This study shows that the Kakuno, et al. films (Fe at 64 wt %) are dark and shiny and are very brittle. After low temperature annealing at 250°C for 8 hrs, the film broke completely into small pieces. Annealing is a qualitative method used to study the impurity contamination of the plated film, because impurity concentration deteriorates the mechanical property of the plated film and this effect can be magnified at an elevated temperature. The Kakuno, et al. films were annealed at low temperature to indicate the presence of impurities within the films deposited using the Kakuno, et al. method with the process reproduced conditions recited in section (7) of this paper. The brittle mechanical characteristics of the Kakuno, et al. film indicates high impurity content. In contrast, the inventive CoFe film comprising Fe at 64 wt % equal are still intact after

annealing. Fig 5 in the Kakuno, et al. disclosure shows cracks in the plated films, confirming this finding. Exhibit 2 is an original photocopy of page 3225 of the Kakuno, et al. paper that clearly shows the presence of cracks. This is especially seen in Fig. 5b. An attached optical photograph of the reproduced Kakuno, et al. film also shows cracks. See Exhibit 3. Exhibit 3 also shows an optical photograph of the inventive sample itself which doesn't show any cracks therein.

The magnetic moment for Kakuno's CoFe films comprising Fe present at 64 wt % is 2.2 Tesla compared with 2.4 Tesla for the inventive CoFe films comprising Fe present at 64 wt %. The resistivity of Kakuno's CoFe films at Fe 64 wt % is  $44\mu\Omega\text{-cm}$ , while the inventive CoFe films comprising Fe present at 64 wt % is  $38\mu\Omega\text{-cm}$ . The low moment and high resistivity of Kakuno's CoFe films indicate high levels of impurity concentration in the plated films, which was confirmed by the impurity data discussed in the following pages.

(10) Crystallinity for both the inventive and Kakuno, et al. plated films was also studied, as shown in Exhibit 4. Referring to FIG. 4, x-ray diffraction was used to study the crystallinity of the plated films, prepared in accordance with sections (6) and (7) of this paper. By comparing the figure in Exhibit 4 and Figure 4 of the Kakuno, et al. disclosure, one will find that the Cu disks we used as substrates for plating had the same structure as Kakuno's plates, indicated by the same 2 theta location for the Cu (111) and Cu (002). The intensity of the peak is proportional to Cu plate thickness. The striking difference, as shown by the magnitude of the Co(110) peak, is in the much lower degree of apparent crystallinity in the high Fe wt % CoFe films produced in accordance with the Kakuno, et al. disclosure (64 wt% Fe and 76 wt% Fe) as compared to the CoFe film (76

wt% Fe) produced in accordance with the present invention, where the degree of crystallinity of the plated film is related to the number of peaks and the intensity of these peaks. This means that the grains of the Kakuno, et al. films are much smaller and that the relative volume of intergranular space (proportional to intergranular area) is much larger, and/or that the Kakuno, et al. films are much less textured, again probably due to intergranular phases interfering with textured crystal growth. Since the inventive film and Kakuno, et al. film were plated on the same Cu substrates, the difference in grain structure came from the plated film itself. The finer crystalline grain size and/or the lesser degree of texturing of the Kakuno, et al. CoFe film comprising 64 wt % Fe, as shown by x-ray diffraction, is completely consistent with a higher level of impurities, because of a relatively larger intergranular area occupied by a larger relative volume of impurities that interfere with orderly crystal growth. The fine crystalline grain size and/or lesser degree of texturing was also present in CoFe films produced from the Kakuno, et al. plating bath comprising 76 wt % Fe, as shown by x-ray diffraction.

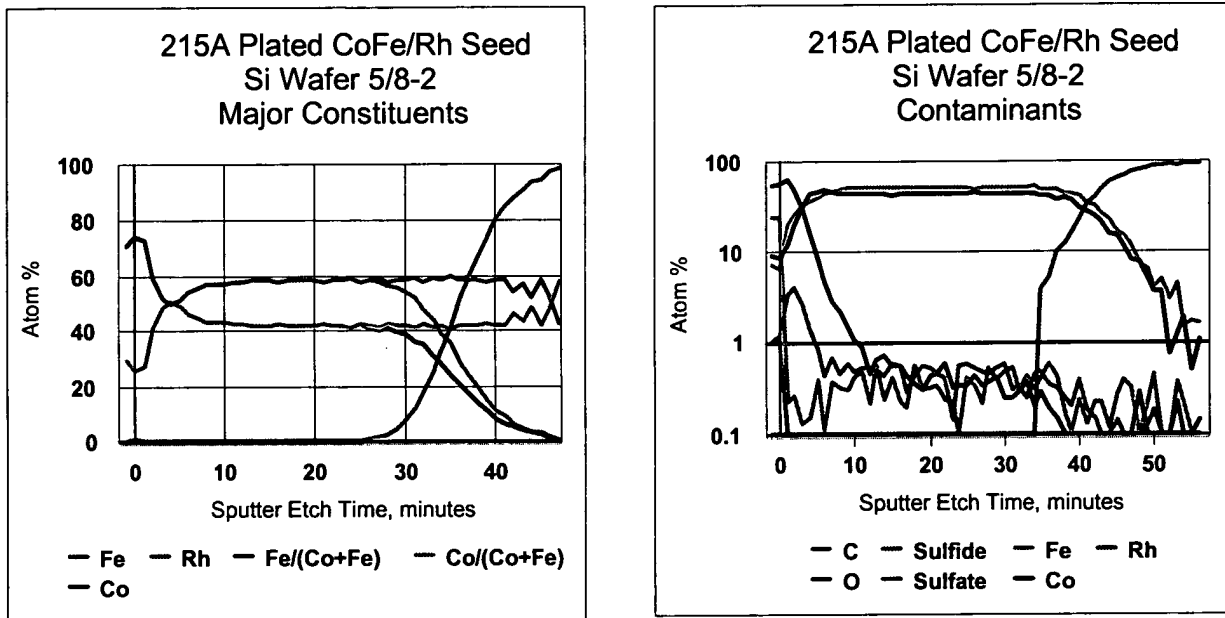
(11) Phi Quantum 2000 Electron Spectroscopy for Chemical Analysis (ESCA) was used to analyze the impurity concentration in the plated CoFe films due to its high accuracy in low level impurity analysis. 5" CoFe films were plating in a paddle cell using Kakuno, et al. and the inventive bath chemistry and plating conditions, as specified in section (3) and (6), respectively. The target plated film composition utilized in the Kakuno, et al. and inventive process is around Fe wt% 60 and Co wt% 40 for both films. ESCA depth profiles show that the film produced by the Kakuno, et al. process has oxygen content in the bulk as high as 5.7 atom %, while the bulk oxygen content in the inventive film is well below 1 atom %. ESCA data also shows that Kakuno's film has

nitrogen content of 0.19 atomic%, while the inventive film is nitrogen free. This is because Kakuno's bath contains Iron Ammoniac Sulfate, while the bath of the present invention has no N-containing constituents. The ESCA data for the above-described films is depicted on Pages 12-14. Because of the high impurity concentration, the composition of Kakuno's film is Fe 59 atomic%, Co 35 atomic% and impurity 6 atomic%. The inventive film has the composition of Fe 60 atomic%, Co 40 atomic% and the impurity less than 1 atomic%. The above composition is express in atomic% because ESCA analysis resulted in atomic%.

The reason why impurities such as O or N can reduce the magnetic moment is that the bulk magnetic moment is a function of the density of atomic magnetic moments per unit volume. The presence of O and N impurities dilutes the magnetic moment by reducing the volume fraction of the magnetic atoms Fe and Co. Furthermore, oxygen converts a portion of the high-moment Fe and/or Co into low or zero moment oxide compounds such as  $\text{Fe}_2\text{O}_3$ ,  $\text{Fe}_3\text{O}_4$ ,  $\text{CoFe}_2\text{O}_4$ ,  $\text{FeO}$  or  $\text{CoO}$  which all have much lower magnetic moment than Fe and Co.

ESCA profile for the inventive film

(Fe 60 atomic %, Co 40 atomic % and the impurity less than 1 atomic %)



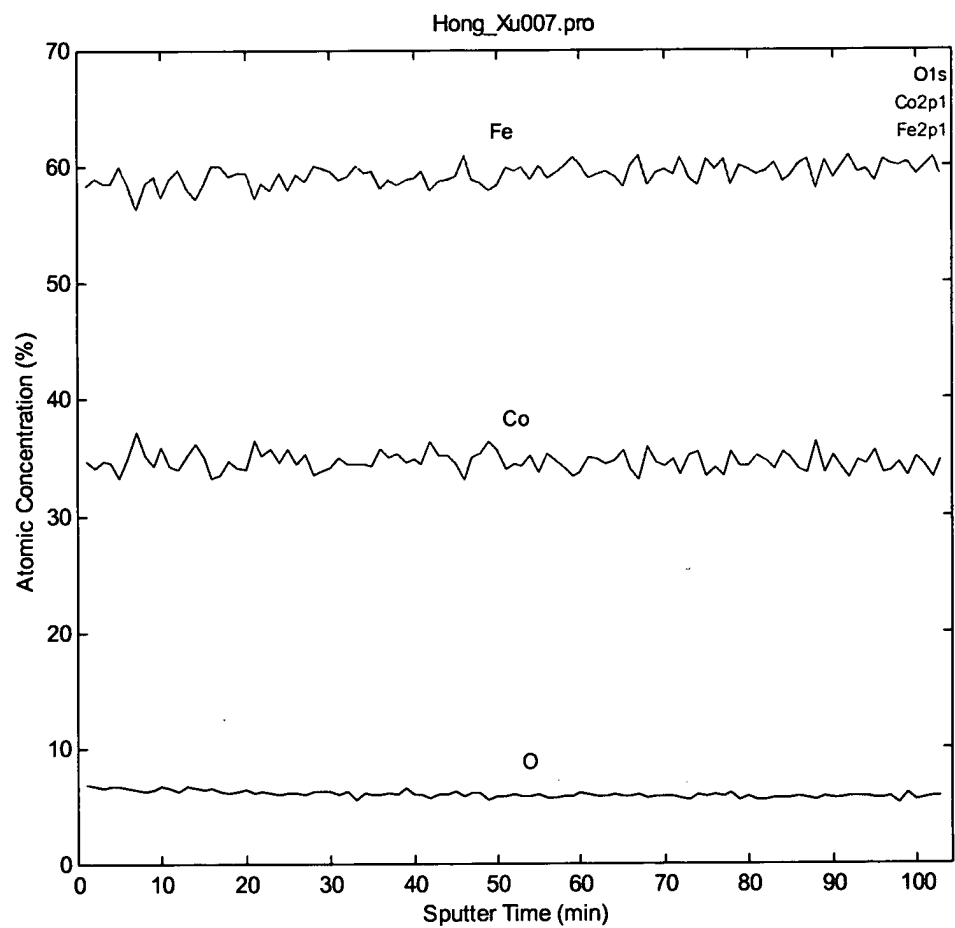
During the analysis, the film was sputtered away and the Co, Fe and oxygen concentration were analyzed (the same was performed on the inventive film). Here, sputter time corresponds to the film thickness. At zero sputter time, the concentrations shown are at the film surface. The above figures show the concentration profile throughout the film. Most importantly, the oxygen concentration for the inventive film was less than 1 atomic % in the bulk.

The following Figure is ESCA profile for the Kakuno, et al. film produced using the conditions recited in section (7). The profile shows that the oxygen concentration for Kakuno's film was as high as 5.7 atomic% in the bulk.

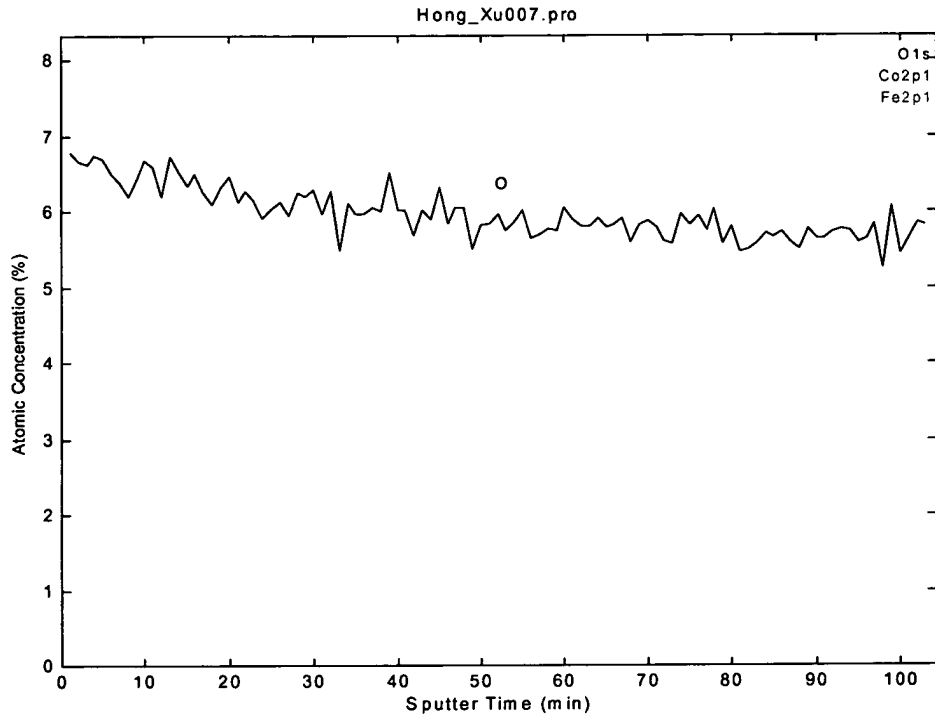
## ESCA profile for Kakuno's film

(Fe 59 atomic %, Co 35 atomic % and impurity 6 atomic %)

Hong\_Xu007.pro: Sulfate + Ammonium CoFe Plated Wafer: Sulfate + Ammonium CoFe Plated Waf Hitachi GST/SJ  
6.7807e+000 max  
Fe2p1/Area1: MD perp exit



Hong\_Xu007.pro: Sulfate + Ammonium CoFe Plated Wafer: Sulfate + Ammonium CoFe Plated Waf Hitachi GST/SJ  
6.0971e+001 max  
Fe2p1/Area1: MD perp exit



Specie	O	N	Sulfide	Sulfate	Co	Fe
Atom %	5.7	0.19	0.062	0.019	35	59

The above figure is a closer look at the oxygen concentration shown in the figure on the previous page of this declaration. Specifically, this figure shows that the oxygen concentration for the prior art film disclosed in Kakuno, et al. is very high, not only on the film surface, but in the bulk as well. The above table shows that the average



bulk concentration of oxygen for Kakuno's film was as high as 5.7 atomic%, and nitrogen was 0.19 atomic %.

(12) Summary: The experiments in this declaration were performed to show differences between the inventive CoFe film and a film that was reproduced in accordance with the disclosure of Kakuno, et al. The table, which is provided above, illustrates that the same plating set-up as disclosed in the prior art paper was used as well as the same substrates for plating. We measured the film composition, magnetic moment, resistivity, B-H loops, crystallinity and impurity concentration of the film prepared in accordance with the Kakuno and compared them to the CoFe film of the present invention. We also measured oxygen and nitrogen concentration in the plated films.

Study shows that there are major differences between the Kakuno, et al. CoFe films and the inventive films at the same composition. The Kakuno, et al. film has a lower magnetic moment on the order of 2.2 Tesla and higher resistance compared with the inventive films. Kakuno's films show much less crystallinity in X-ray diffraction, i.e., have finer grain size and/or less texturing. Kakuno's films are very brittle and collapsed after annealing at a relatively low temperature. All these indicate that the Kakuno, et al. films have high levels of impurities incorporated to the plated films. ESCA data further confirmed that the Kakuno, et al. film has high oxygen content, as high as 5.7 atom%, and substantial nitrogen content, 0.19 atom%, while the inventive film has bulk oxygen concentration well below 1 atom% and is nitrogen-free.

The Kakuno, et al. electroplating process is a different process from the inventive CoFe plating process. We proved that CoFe film properties are determined not only by composition, but also by micro-structure of the film and impurity concentration,

which are directly affected by electroplating conditions. Kakuno, et al. use Iron Ammoniac Sulfate bath without any additives, while in the present invention a purely sulfate bath with an additive to prevent the impurity incorporation into the plated films is used. Study shows that although current density disclosed in the Kakuno, et al. paper is 10-50 mA/cm<sup>2</sup>, which overlaps the disclosed 3-40 mA/cm<sup>2</sup>, plating bath chemistry is the key to plate a high moment CoFe films with extremely low oxygen and free of nitrogen impurities, which directly affect the plated film properties.

(13) All statements made herein, of my own knowledge, are true, and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made may be punishable by fine or imprisonment or both, under Section 1001 Title 18 of the U.S. code and that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

Dated: June 10, 2004

Hong Xu

Hong Xu

APPENDIX C

RELATED PROCEEDINGS

Application Serial No. 09/634,171

There are no pending appeals or interferences related to this application to Appellants' knowledge.